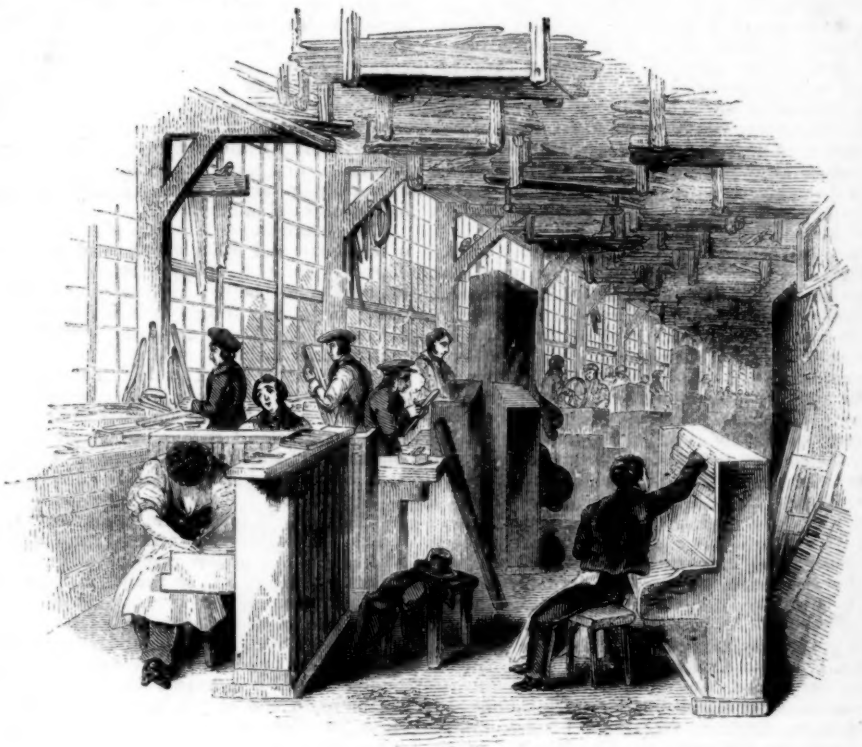
A DAY AT A PIANOFORTE FACTORY



[Interior of Messrs. Broadwood's Factory—West Central Range.

A HUNDRED and twenty years ago, Dr. Arne, then a stripling, who, like many other striplings, loved music much better than the study of the law, used to delight in practising by stealth after the family had retired to rest. He had in his bed-room an old *spinet*, from which, after muffling the strings to deaden the sound, he drew such tones as it could afford, and which have been described as "weak, wiry tones, between a cough and a chirp, elicited by keys rattling like the dry bones of a skeleton."

If Arne, or any one who, like Arne, had been accustomed to the clavichords, the virginals, the spinets, and the harpsichords of past ages, could see a pianoforte of modern times, how great would be the change perceived! All these instruments, together with the psaltery, or dulcimer, act on the same principle, a principle which marks a separation between them and the violin on the one part, and the lute, the harp, and the guitar, on the other. This principle is the striking of a stretched cord, to produce from it the tone due to its length, thickness, and tension; yet though fundamentally the same, how different in effect are these several instruments! The modes in which the principle is modified in the several forms of instruments are curious, and may thus be briefly glanced at. The ancient *psaltery* (nearly the same instrument as the modern *dulcimer* occasionally seen in our streets) was probably the original whence all the others have emanated; and, according to Mr. Hogarth, "consisted of a square box of small depth, over which was placed a sounding-board of fir, and on this sounding-board were stretched a set of strings of steel and brass, tuned to the notes of the scale." They were struck or played upon by two little rods held in the hands of the player. A great change was effected when the little rods were abandoned, and mechanism introduced whereby each string was provided with a lever which struck it. The lever constitutes the key of such instruments as this, and, in the form of an instrument called the *clavichord*, was provided at the hinder end with a little brass wedge that struck the string when the front end of the key was pressed down. To improve the tone elicited from the string the brass wedge was superseded by a quill, and the instrument then acquired the names of the *virginal* and the *spinet*. As a still further improvement, it was proposed to have two strings to every note, so as to increase the volume of sound: this involved a considerable increase in the complexity of the mechanism, and the improved instrument, under the name of the *harpsichord*, was in high repute during the greater part of the last century. At length occurred the happy thought of dispensing with the quills, and using little wooden hammers covered with leather, as a means of eliciting the tones of the strings, a modification which gave rise to the modern *pianoforte*, so named from the power of the

instrument in producing "piano" and "forte," or loud and soft effects.

It has been said, in a recent article of the Westminster Review—"With a little allowable flattery of the truth, the bookcase, in an inventory of the goods belonging to any well-ordered English house, might be designated as one of its necessary articles of furniture—not as one of its luxuries: the place of popularity among the latter being claimed by the pianoforte." Whether we rank it as an article of furniture or as a luxury, it is certain that the pianoforte has become diffused in an extraordinary degree in this country. Those who can carry their recollection back over a period of thirty or forty years, will remember the pianoforte as an instrument for the noble and the wealthy, sparingly seen in the houses of the middle classes: they will remember the gradual steps by which it has reached the domestic firesides of the bulk of the class just alluded to; and they will be prepared to expect that such an extension in the use must have brought along with it extensive plans of improvement, and equally extensive manufacturing arrangements: yet there are probably few, even of those who are familiar with the use of the pianoforte, who are aware of the complex mechanism of the modern instruments, or of the gigantic scale on which the manufacture is conducted. On these points we shall endeavour to offer a few words of information, which we are enabled to do by the courtesy of Messrs. Broadwood, the eminent manufacturers. This firm, which has existed in the metropolis for more than a century, is one of those by whom the pianoforte has been brought to its present state of perfection. Like most other products of ingenuity, this instrument is indebted to many minds for its advancement. One improvement we owe to a Broadwood, another to an Erard, others to the Clementis, the Stodarts, the Tomkisons, &c., and all have profited by the labours of each.

Messrs. Broadwood's principal factory is situated in the Horseferry Road, Westminster, in the immediate vicinity of two other establishments which have already engaged our attention, viz., the "London Marble Works," and the "Westminster Gas Works." Whoever might conjecture that a pianoforte factory was merely a large workshop in the rear of the wareroom in which the finished instruments are sold, would be somewhat astonished at visiting the one to which we allude. In the Horseferry Road are two double gates, opening into courts or quadrangles; and in Holywell Street, three hundred feet southward of it, are two other gates, also opening immediately on the same quadrangles; and the whole of the intermediate space, spreading to a wide extent east and west, is occupied by the factory. On entering one of the gates, we find before us a long open court, occupied principally by piles and tiers and logs of wood, and bounded on either side by ranges of workshops extending three hundred feet in length. Advancing half-way along the court, we find, on either side, an archway, leading beneath the buildings to other courts or open quadrangles, one to the east and one to the west of that by which we enter: these quadrangles, like the first, are bounded on both sides by long and uniform ranges of workshops. We are then enabled to see the extent and form of the factory. It consists of four parallel ranges of buildings, every range lighted by windows on both sides, and having in general three tiers or stories of workshops in height.

The four ranges are separated by the three courtyards, and at the ends are four or five dwelling-houses inhabited by the superintendents and foremen of the establishment. Each range is wide enough to have in most parts two workshops in width; and as most of the ranges are three stories in height, there is an aggregate length of workshop truly enormous, in fact it considerably exceeds *half a mile*—an extent to which there are probably very few parallel instances in the metropolis.

In these four ranges of buildings three or four hundred men are engaged on the various component parts of pianofortes, from the first sawing of the rough timber, to the polishing and regulating of the finished instruments. Besides these there are many others engaged in the smaller branches of the manufacture, who do not work on the premises. In many of the workshops the employment seems to the eye of a stranger to differ but little from common joiner's or cabinet work; while in others it has evident relation to musical arrangements. These distinctions we may exemplify by taking a hasty glance through all the four ranges of buildings.

The eastern range is occupied at one end by stores of mahogany and other woods, piled up for seasoning Then we come to shops occupied by 'packing-case makers' and 'bottom-makers,' the latter of whom make the strong framing which forms the bottom of a pianoforte. Above these are workshops in which 'square-case makers,' and 'sounding-board makers' or 'belly-men,' are at work. To understand these technical terms, it may be well to remark that modern pianofortes are divided into five classes, viz., *grand, semi-grand, cabinet, cottage,* and *square* (the distinctive characters of which we shall explain farther on); that each workman generally confines his labours to one of these kinds; and that the 'case' is the hollow box in which all the mechanism of the instrument is contained. A 'square-case maker,' then, is the workman who makes the hollow case for a square pianoforte. The 'sounding-board,' or 'belly,' is a thin plank of fir, to which some of the internal mechanism is fixed; and its use is to augment the sounds emitted by the strings: the 'bellyman' is the maker of a 'sounding-board.' The upper floor of this range, like part of the middle floor, is occupied by 'square-case makers.' At the north end of this building are extensive open sheds, in which mahogany and lime-tree logs and planks are stored up for seasoning previous to use.

In the open quadrangle which separates the east range from that which we will call the east central range, are piles and stacks of mahogany, deal, beech, sycamore, and other kinds of wood used in the manufacture, every log and plank being marked to denote the time during which it has been exposed to the seasoning operation of the air, and all arranged with the utmost system and regularity.

On crossing this court-yard to the east central range of buildings, we find numerous workshops, some of them as much as a hundred and twenty feet in length, occupied by workmen in various departments. On the ground-floor are the 'cutting-room' and the 'seasoning-room' or 'hot-room.' The former of these is the room in which the principal pieces of wood for a pianoforte are marked out and cut roughly into shape. Like the ship-builder and the coach-builder, the pianoforte-maker shapes the various pieces of wood by moulds or pattern-pieces, tracing chalkmarks for the guidance of the saw. The 'seasoning-room' is one which exemplifies the scrupulous care taken in the preparation of the wood before its employment in the manufacture. Every separate piece, after having been exposed to the air for some years, is before final use brought into this room, and kept for a long time exposed to a temperature of about one hundred degrees until the fibres are brought to a state of dryness as complete as can be obtained. The 'seasoning-room' is heated by hot-water pipes; and it is also provided with a steaming-tank for steaming planks which are to be bent to any required curve.

Another portion of the lower floor of this range is occupied by 'hammer-makers,' workmen employed in making the minute and complicated mechanism by which the keys are brought into connexion with the strings. 'Cleaners-off' and 'polishers' occupy other portions of the floor; their employments, as the terms seem to imply, having reference to the instruments when in a nearly finished state. Adjacent to these are rooms in which finished instruments are placed before being sent from the factory. The middle floor of this range exhibits long workshops occupied by various classes of workmen, among whom are 'grand,' 'semi-grand,' 'cabinet,' and 'cottage sounding-board makers,' or 'belly-men, whose office we have before alluded to; 'cottage-case makers' and 'cabinet-case makers.' In continuation of the same story are shops for 'fitters-up' and 'top-makers,' the former of whom put together the various component parts made by other workmen, while the 'top-makers' fabricate the lids or covers of the instrument. On the upper floor are repetitions of some of the arrangements seen below, such as 'case-makers,' 'belly-men,' and 'finishers,' together with another class of workmen not yet spoken of—viz., the 'key-makers.' Contiguous to the northern end of this range is a series of saw-pits, in which the logs are cut.

Proceeding through an archway westward we now come to the central court, occupied, like the eastern one, principally with piles and logs of mahogany. Open sheds, too, placed in various parts of the factory, exhibit an enormous quantity of wood, most of which is of a fine and valuable character. The value and importance of the stock of timber kept on hand in an establishment of this kind rest on two grounds, the beauty and excellence of the wood itself, and the necessity for allowing every plank and log to be thoroughly seasoned before use. The log lies a long time before it is cut into planks; the planks are left through another long period before they are cut into shape for use; and the pieces thus cut are again left some time to season; so that almost every piece of wood employed in a pianoforte remains in the factory several years before it is finally used. This entails an enormous investment of capital; for there is on the premises a stock of wood sufficient for two years' manufacture, equivalent to about five thousand pianofortes.

The workshops on both sides of the middle court exhibit scenes of busy industry similar to those before noticed. There are 'case-makers' and 'belly-men,' 'fitters-up' and 'polishers.' Besides these there are, in the east central range, a 'veneer store-room,' in which valuable fancy-woods are kept; shops for 'hammer-makers,' 'hammer-rail makers,' and 'desk-makers.' At the northern end of this range is an engine-house, and also a shed for mahogany logs. Some of the buildings, too, have flat leaded roofs, on which timber is placed for the better exposure to air and sun. Near the principal entrance to the premises, and in the same range, is the store-room of the principal foreman, in which all the smaller articles required in the manufacture are kept. This room, and the whole arrangements connected with it, are conducted on the most scrupulous system, an indispensable requisite where several hundred workmen are to be supplied with working materials.

On the opposite side of the middle court is the range which, for the sake of distinction, we will term the west central range. Our frontispiece presents a view through part of one of the workshops in this range, and will serve to convey some idea of the general appearance of these extensive shops. It is one of the 'cabinet finishing shops' where the cabinet pianofortes go through some of the later processes of the manufacture: for the sake of clearness, only one-half the length of the shop is shown in the cut

The shop just alluded to is on the middle floor of the west central range; the upper floor being occupied by 'square-case makers' and 'belly-men;' and the lower by 'regulating and tuning rooms,' a 'glue-room,' a 'rosewood-store,' and a 'veneer-room.' In this latter room we saw, among other costly specimens of veneer, some slabs or sheets taken from a tree which has had much notoriety, and which strikingly illustrates the value placed upon fine wood. Logs for veneers are valued partly on account of the beauty of the pattern or figure, and partly on account of the size and soundness of the veneers which may be cut from them; and in the instance here spoken of the two qualities were combined in an unprecedented degree. It is generally known that Honduras mahogany is not so highly valued for cabinet-work as Spanish mahogany; it is therefore in the pianoforte manufacture used for some of the parts which are afterwards veneered with Spanish mahogany, rosewood, or some other kind of fancy wood. But in the present case a tree of Honduras mahogany, imported about sixteen years ago, has far exceeded what Spanish wood could exhibit. The circumstance was thus alluded to in one of the volumes of the 'Library of Entertaining Knowledge,' a few years ago:—"Spanish mahogany is decidedly the most beautiful; but occasionally, though not very often, the Honduras wood is of singular brilliancy; and it is then eagerly sought for, to be employed in the most expensive cabinet-work. A short time ago Messrs. Broadwood, who have long been distinguished as makers of pianofortes, gave the enormous sum of three thousand pounds for three logs of mahogany. These logs, the produce of one tree, were each about fifteen feet long and thirty-eight inches wide. They were cut into veneers of eight to an inch. The wood, of which we have seen a specimen, was peculiarly beautiful, capable of receiving the highest polish; and, when polished, reflecting the light in the most varied manner, like the surface of a crystal; and from the wavy form of the fibres offering a different figure in whatever direction it was viewed."* The price, we are told, is here erroneously stated at three thousand pounds; it was about two thousand, averaging nearly five guineas per cubic foot! The figure of this wood somewhat resembles the ripple or small waves of water gently moved by the wind; and perhaps from this circumstance it has obtained in the factory the name of 'ocean-wood.'

An archway under the west central range leads us to the western court, which will terminate our tour of the premises. The workshops on either side of this court exhibit, in addition to some similar to those before noticed, a 'turner's shop,' where the legs for pianofortes are turned; a 'stringer's shop,' where the strings are attached to some of the instruments; and shops wherein are made a number of minute pieces of mechanism connected with the keys, such as hammers, dampers, &c. This open court, too, like the others, has its stores of timber; and at one end of the west central range is a series of about ten or a dozen saw-pits, where the logs are cut into planks.

It would be no easy task, nor indeed would it be necessary, to describe the arrangements of the various departments of workshops. It may suffice to say that they bear some resemblance to the shops of a cabinet-maker, in relation to the materials and the tools employed. The work-benches, about three hundred in number, are placed in general transversely, with one end towards the windows; and on the side opposite to the windows are the stoves and fire-places for warming glue, and other operations in which heat is required. Overhead, in nearly all the shops, are piles of wood in various stages of preparation for the use of the work-

* 'Timber Trees,' p. 175. 1829.

men, and undergoing the last process of seasoning by the warm temperature of the shops. A better idea of the nature of the several employments may perhaps be gathered by tracing, in a cursory way, the progress of a pianoforte in its several stages of manufacture.

Whatever form or value the pianoforte may have, it consists of a case containing stretched wires, which wires are struck by soft hammers, attached to the hindmost end of the finger-keys. This being the general character of the instrument, the various subdivisions are as follows. It was stated in a former paragraph that the *harpsichord* was an improvement on previous instruments, by having two strings to every note: this improvement has been retained in the pianoforte, together with the later one of having soft hammers instead of quills. The "tinkling grandfather of the pianoforte," as the *clavichord* has been called, had but four or five octaves; the harpsichord five or five and a half; but the pianoforte has extended its range to six and a half. These points being remembered, then, we may state, 1st, that the *square* pianoforte has the strings horizontal, in a rectangular case, with two strings to each note, and a compass varying from 5½ to 6½ octaves. 2nd. The *cottage* pianoforte has its strings arranged vertically, reaching nearly from the ground to a short distance above the level of the keys: the case is much shorter than in the 'square;' there are two strings to each note; and the compass is generally six octaves. 3rd. The *cabinet* pianoforte is much higher than any other, except the *upright grand*, a form not now manufactured; the strings, two to each note, are ranged vertically, but, unlike those in the *cottage* form, are elevated wholly above the level of the keys: in general the compass is six octaves, but the most finished instruments have a compass of six and a half. 4th. The *grand* pianoforte is longer than any other; it is wider at one end than the other, and, unlike those hitherto mentioned, has the keys at one end; the strings are horizontal, and the chief feature whereby the instrument is distinguished is, that there are *three* strings to each note; the compass is always six octaves and a half, and there are thus upwards of two hundred and twenty strings. 5th. The *semi-grand* pianoforte is, as its name imports, a modification of the 'grand;' it has the strings horizontal; its case somewhat resembles that of the 'grand,' but it is shorter, has a compass of only six octaves, and has but two strings to a note. These are the five forms of pianoforte now made; and the manufacture of course involves certain modifications to suit the various forms. As a means of showing the relative proportions in which these several forms are manufactured, we find that out of the eighty or ninety thousand pianofortes which have been made by this firm, there have been, to every hundred 'squares,' twenty-eight 'grands,' sixteen 'cabinets,' nine 'cottage,' and five 'upright-grands' and 'semi-grands;' so that the 'squares' constitute nearly two-thirds of the whole number.

The case, being a hollow box veneered on the outside, is made in a manner nearly similar to cabinet-work generally. In the 'square' form it is an oblong rectangle; in the 'cabinet' it is lofty; and in the other three forms it is modified in various ways. The most scrupulous care is taken in the selection of wood, not only in reference to its perfect dryness, but to the combining of two or three sorts together, so that each kind of wood may render its peculiar properties in aid of the others. Nearly all the work-benches at the factory are provided with a simple but valuable arrangement for pressing and keeping together the pieces of glued wood while drying. At a height of about four feet above the bench is a horizontal board or false ceiling; and the glued pieces being laid on the bench, a number of elastic wooden rods are placed nearly vertical between the false ceiling and the bench; being longer than the interval in which they are to be placed, they can only be adjusted by a slight bending or convexity in their length; and this bending gives them a very powerful pressure on the bench beneath or on the glued pieces placed on the bench. In some instances we saw thirty or forty of these bent vertical rods employed on one piece of wood. When the gluings are dry, a slight blow or jerk will remove each rod.

Without attending to the technical names applied to the various parts of a pianoforte, we shall, perhaps, be understood by general readers when we speak of the *frame-work* of the instrument as distinct from the mere outer case. If we open a pianoforte, especially a 'grand,' we shall see bars and rods and strengtheners of various kinds, placed in different directions, not only with a view to give form and stability to the instrument, but to resist the powerful strain to which it is exposed by the tension of the strings. This tension is truly extraordinary, and requires for its due appreciation a little consideration of the phenomena of a stretched string or wire. Let us suppose that a wire is wound round two pegs or pins placed a yard apart, and that it is merely brought into a straight line without any attempt at stretching it. If struck with a soft hammer, it will yield a low sound, due to a small number of vibrations per second; but if we wish to elevate the pitch of the tone, we can do so by increasing the tension or stiffness of the wire. A tuning-key being placed on one of the pegs to which the wire is attached, the peg can be turned round, and a portion of the wire wound on it: this necessarily increases the tension of the portion of wire extending between the pegs; the increase of tension increases the rapidity of vibration when the wire is struck, and this increased rapidity gives a more elevated pitch to the tone elicited. Now, in conformity with one of the laws of force, the wire pulls with a power equal to that by which it has been stretched; it tends to regain the state which it originally had, and by this tendency exerts a powerful dragging or pulling force on the pins to which its two ends are attached, and on the frame-work wherein the pins are inserted. This force is exerted by every wire, according to the tension given to it; and the aggregate force is surprisingly great. It is calculated that the two hundred and twenty-five strings or wires of a grand pianoforte exert a strain of more than twenty thousand pounds! This is in fact the force tending to draw together the two ends of the frame-work to which the wires are attached. It need hardly be observed, therefore, that the frame-work must be made with great strength. The various pieces of wood are in many places glued up so that the grain of one component part shall extend in one direction, and that of the other at right angles to it; different kinds of wood are used in different parts; an iron rod is placed here, an iron plate there; and contrivances of various kinds are introduced to give most strength where most strain will be experienced. The 'action' of a pianoforte (of which we shall presently speak) is, perhaps, more complicated in a 'cabinet' than in any other form; but the mechanism connected with the strings is far more complex in the 'grand.'

The mere attachment of each wire to pegs at its two ends is not sufficient for the adjustment of its tone. The whole length of wire is not allowed to vibrate when struck, but only a given length of it from one end to a pin inserted in a curved piece of wood. The adjustment of these vibrating lengths to the different strings is a matter of great delicacy, and may perhaps be rendered comprehensible by the few following remarks. There are three modes of producing an elevation of pitch in a vibrating string:

1st, by shortening the string; 2nd, by increasing its thickness; or 3rd, by increasing its tension. Now the manufacturer does not adopt any one of these methods of adjusting tones, to the exclusion of the others: he avails himself of all. Twelve strings of the same length and thickness might be so different in tension as to yield the twelve semitones of an octave; twelve strings of the same thickness and tension might be of such different lengths as to yield the twelve semitones; or, lastly, twelve strings of the same length and tension might be made to produce these effects by having the thicknesses different. But in practice the tones produced by either of these methods would be very defective in character. Each degree of thickness, of length, and of tension, produces its own peculiar effects on the '*timbre*,' or quality of tone. If two strings of the same length and thickness were so stretched as to produce tones differing by an octave in pitch, one would be strained nearly to breaking, and the other would produce a dull, weak, and smothered sound. If, while producing these two notes, the strings differed only in length or in thickness, the qualities of tone would not be so much at variance as in the case just supposed; but still the required equable character of tone would not be produced. The plan adopted, therefore, is, to let the length, the thickness, and the tension, all vary together.

This explanation will enable us to understand the reason for the observed difference in the strings of the pianoforte. We perceive that the strings for the upper notes are not only shorter but also thinner than those for the lower; and we should find, though it is not perceptible to the eye, that the tension is likewise different. The thickness, the length, and the tension, all diminish (but not uniformly), from the lower to the upper notes; *tension* being here used to express the force employed in stretching the string to the required degree. In a grand pianoforte there are fourteen different thicknesses of wire; the smaller, for the upper notes, being plain polished steel-wire, and the thicker, for the lower notes, being coated with a very fine coil of copper-wire.

In adjusting the strings there are certain rules as to the thickness of wire selected for a certain note; and the vibrating length of each string is regulated by a curved piece of wood called a bridge, fixed to the sounding-board of the instrument. To make and adjust this bridge is one of the most delicate operations of the 'bellyman' or 'sounding-board maker.' The curve itself is regulated by a gauge to which the maker works: so is the position which it is made to occupy in the sounding-board; and so likewise are the order and arrangement of the pins inserted in it. These pins are so placed that the strings rest against them, each string being bent out of its rectilinear course by coming in contact with a pin. A portion of the string is thus effectively cut off, so far as regards the vibration; and the manufacturer is thus enabled, by the adjustment of the pins in the sounding-board, to give to the strings any vibrating length corresponding to the tones to be produced. So complex and important are these arrangements, that the strings of an improved grand pianoforte require nearly one thousand iron pins or pegs, each one inserted in a hole made with great exactness to its dimensions. The workmen called 'stringers' fix the proper strings to the proper pins. The wire is sent from the wire-drawer in coils about five or six inches in diameter, each coil containing enough wire for several strings.

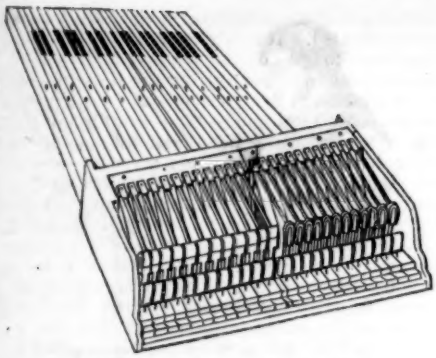
Hitherto we have said nothing of the mechanism by which the strings are struck,—by far the most curious part of a pianoforte. This mechanism obtains the general name of the 'action;' and when we hear of 'square-action,' 'grand-action,' &c., we must understand these terms to allude to the particular mode in which the percussion is effected. It is perhaps scarcely too much to say that three-fourths of the improvements which the pianoforte has undergone during the present century have had relation to the 'action.' All the great firms for which the metropolis is distinguished in this branch of manufacture have brought forward some or other improvements in this respect; and their united labours have raised the instrument to such a stage of perfection, that—like the chronometer—there is little more to be wished for, unless indeed it were possible to obtain the *sustained* tones of the organ.

The most obvious part of the 'action' is the key-board and its mechanism. Every ebony or ivory key is a lever, which, when pressed down at the foremost end, rises at the hindmost, and this leverage is the source of all the effects subsequently produced. A little examination of these keys will show that the ebony is solid, but that the ivory is merely a veneer or scale put on a substratum of wood. The white keys are made of carefully prepared lime-tree wood, which is cut after the pieces of ivory are attached. The annexed cut shows the appearance of the key-board

[Key-cutter at work.]

while being cut up into keys. The pieces of ivory are shaped and prepared by the ivory-worker to the exact size for each key, and are glued side by side on the surface of the wood. The wood is marked out by a gauge, and is then cut up into parallel pieces for the keys, by means of a slight frame-saw. A notch is made in the stem or shaft of every white key to receive the ebony key and its stem. When all the keys are cut, a little piece of mechanism is placed in one particular part of the length of each, to form a fulcrum.

To the hindmost part of each key is attached the mechanism whereby it is made to act upon the string; and this mechanism, to which the name of the 'action' is more particularly applied, presents a complexity of arrangement that will baffle everything like a popular description. Simple as the 'square' pianoforte is when compared with the other forms, yet the following cut will show that the 'action' attached to each key is anything but simple. This cut represents a 'square treble-action,' that is, such a portion of the keys and connected mechanism as belong to about an octave and a half of the 'treble' or upper part of the instrument. This piece of mechanism is represented as viewed from behind, the most favourable position for displaying the intricacies of the 'action.' It is seen that there are a number of small pieces placed at various angles, and acting upon one another by various species of leverage.



[Treble-action of Square Pianoforte.]

But this 'action' dwindles into insignificance when compared to that of a cabinet pianoforte in its most improved form. We know of nothing, except the mechanism of a watch, to rival the latter in intricate combinations. One part of the mechanism attached to each key is to cause the hammer to strike on the string; another is to regulate the degree of strength or softness with which the blow is struck; a third is to prevent the rebound of the hammer after the blow; and others are to produce modifications of effect so minute that nothing but the most refined skill in pianoforte playing could render them either appreciable or necessary: indeed the advance of the manufacture, and the advance of the players in skill, reciprocally measure each other; for while on the one hand the resources of the instrument were never thoroughly known until a Liszt, a Thalberg, a Herz, or a Moscheles developed them; so on the other hand these great players would never have been able to produce the exquisite effects for which they are so celebrated, unless the manufacturers had made important and repeated advancements in the progress of the instrument towards perfection.

At the end of this article is given a wood-cut to illustrate the general appearance which the 'action' of an improved cabinet pianoforte presents before the silken covering is applied. Yet this 'action,' complex as it appears, can give but a faint idea of the minute details involved in the mechanism. Nearly the whole of the long slender rods, the levers, &c., here seen have nothing to do with the striking of the strings; they relate merely to the production of some of those delicate effects, those minute shades of tone, which are not sought for in the average style of instruments. The mechanism here seen forms the 'front action;' and on this being removed, another series, still more complex than this, is displayed; and on the removal of this latter, which is the 'action' properly so called, we see the strings themselves, the percussion of which is the object of all this intricate assemblage.

We have thought that the matter now under consideration could not be better illustrated, for general readers, than by ascertaining the number of separate pieces concerned in this mechanism. This has been kindly done for us by one of the superintendents; and we find that in one of Messrs. Broadwood's most improved six-and-a-half octave pianofortes (for which, we believe, a patent has been taken out) the mechanism connected with the 'action' consists of about *three thousand eight hundred* separate pieces of ivory, ebony, cedar, sycamore, lime-tree, mahogany, beef-wood, oak, pine, steel, iron, brass, lead, cloth, felt, leather, and vellum. Every one of these has to be fashioned with the most scrupulous exactness, and as scrupulously adjusted to its place. Many of the pieces are not more than a quarter of an inch square, some even less. The qualities of all the varieties of wood are closely studied, in order to determine their particular aptitude for the different parts, and it is thus that so many as seven or eight kinds are used in the 'action' alone. One kind is preferred because slender rods made of it will not warp; another kind because the grain is straight; a third because it is hard and smooth; a fourth because it is soft and smooth; and so on. Some of the rods are as much as three feet long and only a sixth or seventh of an inch in thickness. To give the technical terms applied to all these little pieces would be of no use; for after saying that the key acts on the 'grasshopper,' and the 'grasshopper' on the 'under-hammer,' and the 'under-hammer' on the 'sticker,' and the 'sticker' on the 'hammer,' and the 'hammer' on the string, we have done but little towards explaining the particular construction and action of each.

When we say that all these minute pieces are fashioned and adjusted by hand, it will be readily conceived that an important part of the arrangements of the factory has reference to them. One of the workshops is entirely occupied by the 'key-makers,' who prepare the lime-tree of which the body of the key is made, glue on the pieces of ivory, cut the keys to their required widths, arrange the little pin or fulcrum, &c. Other workmen make the slender cylindrical rods of pine or of pencil cedar. Some are forming the 'hammers,' others the 'under-hammers,' the 'dampers,' the 'grasshoppers,' &c. An important and very curious part of the labour is the adjustment of the little pieces of vellum, cloth, felt, and leather, Vellum is used for the hinges of some of the minute parts; the two ends or edges of the vellum being glued into slits in the two pieces which are to be hinged together; and it thus forms a hinge peculiarly delicate in its action. The little pieces of cloth are used in various ways for subduing the rattling sound which pieces of mechanism would be apt to produce, and which would interfere with the tones of the instrument. To such a degree of refinement is this carried, that small holes not above a twelfth or fifteenth of an inch in diameter are lined with cloth, in order to give a smoothness to the motion of a wire which passes through the hole. The felt and the leather are principally employed as coverings for the hammers and dampers which come in contact with the wires, and which are thus covered to give mellowness to the tone. If a stretched wire be struck by a piece of wood or of metal, two sounds are heard; one due to the vibration of the wire itself, and the other to the blow which the striking substance gives: to get rid of this latter sound is the object of leathering and felting the hammers. The felt used for this purpose at Messrs. Broadwood's, and which is a beautifully soft white substance about a fourth or fifth of an inch thick, is said to be made from wool grown on Prince Esterhazy's estate in Hungary, the quality of this wool having been found admirably adapted, from its softness, for this purpose.

In speaking of the strings for the various forms of pianoforte we stated that the 'grand' has three strings to each note; and that each of the other four forms has two. The adjustment of all these strings is an important matter, and devolves upon the 'regulators' and 'tuners.' It will of course be understood that in such a case the two or three strings belonging to one note must be tuned in unison; and to effect this the strings are, as may be supposed, of equal lengths and thicknesses. The object then is to bring them to an equal degree of tension, by which the tones may be of the same pitch. The persons employed at this avocation are such as are able, from accuracy of ear, to determine musical intervals with much precision. In our concluding cut the 'cabinet' pianoforte is repre

sented as undergoing the process of tuning. We may here remark that the 'regulation' involves something more than the determination of the musical intervals between the several tones: it relates also to the easy and proper action of the keys, and the general fitness of all the parts for the office which they are to serve.

A portion of pianoforte mechanism to which we have not yet alluded is that connected with the *pedals*, resembling all the other portions in the high degree of care necessary in the manufacture. These pedals serve two totally distinct offices, one of which relates to all kinds of pianofortes, and the other to those only which are provided with three strings to every note. The first govern the 'dampers,' and their use may be thus explained. In order that the harmonies in a piece of music may produce their due effect, it is necessary that the preceding notes should not continue to sound long after the keys have been struck, else discord may usurp the place of harmony. For instance, if the note C were sounded, and the next note of the piece of music were D, the continued sounding of the C after the D has been struck would give the discordant interval of a 2nd, which the ear cannot tolerate, except as a foil to more perfect intervals. Hence mechanism is provided, whereby a soft hammer or 'damper' is made to fall on the vibrating string directly the finger is removed from the key, and this damping smothers the note by stopping the vibrations. As, however, it is desirable in some pieces of music to have the full effect of the vibrating strings after the fingers are removed from the keys, the player is enabled, by pressing his foot on a pedal, to remove all the 'dampers' from the strings, with which they do not again come in contact until the pedal is released. In some of the older square pianofortes this adjustment is made by means of a handle situated near the left hand of the player; but we believe that in all the modern instruments a pedal affords the requisite leverage. The other kind of pedal, used only in grand pianofortes, is employed for the purpose of removing one out of every three strings from the action of the hammers. If three strings were struck by every hammer every time that the key belonging to that hammer is played upon, the player could not obtain the *piano* passages which add so much to the grace and effect of music. There is, therefore, a provision for lessening the quantity of sound—for such is in reality the operation—by lessening the number of strings struck by each hammer. This is effected by shifting the entire key-board to a small distance from its usual position, whereby each hammer clears one of the three strings, and only strikes the other two. The foot-pedal effects this shifting by intermediate levers, and the player has thus the whole arrangement within his power.

Among the minor operations in the manufacture is the preparation of fret-work or open-cut boards for the front of some kinds of pianofortes. This is effected in a very quick and elegant way. The device being marked on the board with chalk, the board is fixed vertically in a kind of vice, and, as represented in the annexed cut, is sawn by means of an extremely fine and thin saw, which follows all the turnings and windings of the chalk-marks, penetrating to every angle, however acute, and severing the small pieces, the absence of which constitutes the pattern. The other ornamental features we must dismiss without any particular notice, as involving no principle but that which distinguishes common cabinet-work. We may, however, notice that the turned legs for the better kinds of instruments are produced by a beautiful lathe, the action of which is of a highly scientific order. An hexagonal or octagonal pattern is produced in a circular leg, by allowing the leg to remain stationary,

[Fret-cutter at work.]

and making the cutting tool revolve rapidly at such a distance from it as to cut away one-sixth or one-eighth of the surface. The cutting tool has at the same time a motion backward and forward in the direction of the length of the leg. The principle of action very much resembles that of the wheel-cutting engine described in our last supplement.

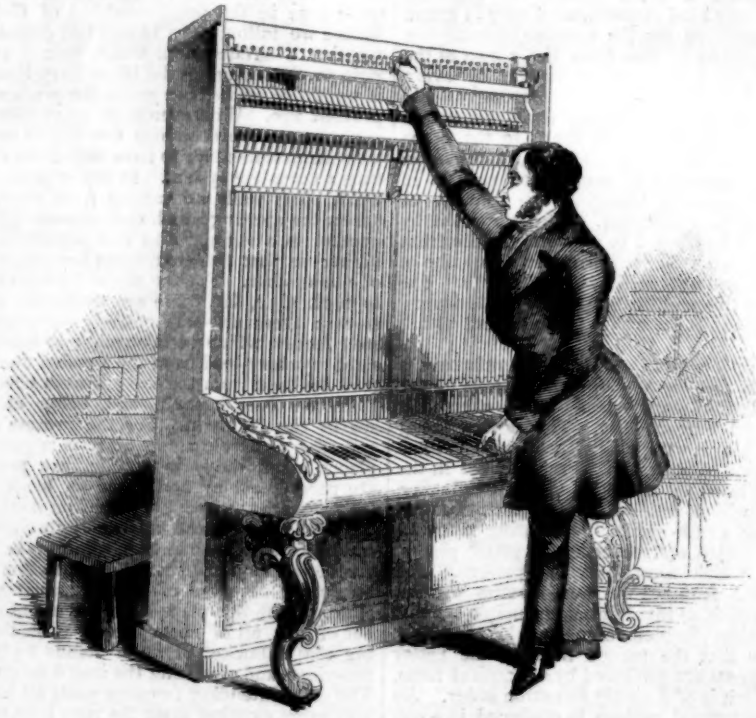
When the various component parts of the pianofortes are put together, the tones regulated to something like accuracy, the exterior adorned with polishing, carved ornaments, &c., and all rendered nearly complete, they are conveyed to another establishment belonging to the same firm in the neighbourhood of Golden Square. Before we follow them to this last depository, we will mention a circumstance which struck us during the visit to the factory at the Horseferry Road, and which is worthy of notice; we mean the precautions taken to prevent fire. Wherever large quantities of dry wood are used, such precautions are highly necessary; but we seldom remember to have seen them carried out on such a complete system. In many parts of the factory brick party-walls are carried from front to back, and across the opening which connects one department with another is a sliding iron door, carefully closed every night; so that the connection is entirely cut off from one to another. For the use of the workmen who have to melt glue, &c., there are about fifty large German stoves: these are each entirely surrounded by a high iron fender, which rests on stone or brick-work, separated by sheet-lead from the wooden floor beneath; so that the heat from the stove is most effectually cut off from the floor beneath, and, being close stoves, no sparks can fly about. For the process of veneering, and others wherein an open fire is required, large fire-places, about thirty in number, are provided: these are surrounded by and based on brick; and in the front of each is a heavy sliding iron door, working vertically in grooves and balanced by weights. The door can be lowered in an instant, whereby the fire is not only completely shut out from communication w..h the shop, but, being deprived of draught, must necessarily decline. Each fire-place is for the use of a certain number of men, all of whom take by turns the office of seeing that a bucket of water stands by the side of the fire-place, and of closing the iron door on leaving work. The superintending foreman visits all parts of the factory every evening after the men have left, and if any one of the sliding doors is seen open, the man whose

turn it was to attend to it is subjected to a fine. If, notwithstanding these precautions, a fire should break out, a fire-engine, a coil of leathern pipe, a plug connected with the water-main, and other mechanism of a similar kind, are at hand, and can be brought to bear upon any part of the factory at a few minutes' notice. —These are arrangements which we should be glad to see adopted in every well-ordered factory.

The music-vans which bear the name of "Broadwood" are employed not only to convey pianofortes to the houses of the purchasers, but to convey them in the first instance from the factory in the Horseferry Road to Great Pulteney Street, Golden Square, where is the original establishment belonging to the firm. Before the great extension in the use of the pianoforte, the operations of the firm were wholly carried on in Pulteney Street and in a range of buildings extending from thence to Golden Square; but now, although there are here upwards of a hundred and fifty persons employed, the pianofortes are principally made at the factory which we have just left. The stock of instruments required to be kept on hand is so extremely large, that a wide range of ware-room is necessary. Almost every room in two large houses in Pulteney Street and one in Golden Square is occupied either in this way, or else by tuners who are giving the final regulation to the tones of the instruments: this adjustment cannot be effected in a large room where many are similarly employed, on account of the confusion of sound which would result; and there are therefore seldom more than two tuners in one room. Some of the apartments are store-rooms for 'grand' pianofortes, some for 'cabinet,' some for 'cottage,' some for 'semi-grand,' some for 'square;' others are for second-hand instruments; a large range of workshops is principally occupied by workmen engaged in 'grands,' the internal mechanism of which is prepared here; others are repairing and adjusting stock pianofortes, many hundreds of which are kept ready for hire. On the ground-floor are ranges of counting-houses and offices, for the cashier, clerks, collectors, &c., belonging to the establishment; in one of which we noticed a portrait, by Hogarth, of the original proprietor of the establishment, a picture which has probably occupied its present place for more than a century.

The pianoforte manufacture is one in which nothing but highly-skilled manual dexterity can make and adjust the numerous pieces of mechanism involved in it; and those workmen who possess this skill are not likely to be supplanted by any automatic machinery. Hence it happens that the same workmen are seen year after year, occupying their old benches, using their old tools, coming to work and leaving work at the old hours, and seeming as if the old shop belonged to them and they to the shop. We noticed, not only that many of the workmen in the factory are elderly men who have occupied their present situations twenty, thirty, or forty years, but that a kindly feeling prevailed among all, illustrative of mutual confidence between the employers and the employed. The patriarch of the establishment is a venerable *ci-devant* foreman, not far from ninety years of age, who has seen out two or three generations of workmen, and whose connection with the establishment dates back through a period of nearly sixty years. That such a man is respected by the firm, and deemed almost part and parcel of it, need hardly be said.

In conclusion we have to thank the proprietors, and the heads of the several departments, for their obliging communications in reference to the subject of the present article.



['The 'Action' or Internal Mechanism of a Cabinet Pianoforte.]